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A BASIS FOR SELECTION OF SPECIES FOR REFORESTATION IN THE CENTRAL HARDWOOD REGION

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The task at hand of reforesting sub-marginal lands in the central hardwood region makes it imperative that all available information be enlisted to obtain the highest degree of success possible in the undertaking. The selection of species adapted to a region of varied climatic and site conditions is the chief problem needing immediate consideration. A better knowledge of methods of planting is also necessary, but may be acquired as the program progresses. The correct choice of species is fundamental. The ideal basis for planting projects would be a complete record of the responses of a sufficient number of sizable plantations of all the species, made on widely varied sites, which may be logically regarded as suited to the needs.

Plantation Survey. Unfortunately, this basis for appraisal does not exist within the central hardwood region, except possibly for a few hardwood species such as walnut and locust, which have been planted rather extensively throughout the Corn Belt. The recently expanded program of planting for erosion control, watershed protection, and restoration of forests on sub-marginal lands, has naturally been directed toward the unglaciated sections of rough hill-lands lying adjacent to and south of the Ohio and Missouri rivers. An investigational survey of all the established plantations that could be located within this region, made by the Station in 1934-35, disclosed the fact that they are inadequate to permit a conclusive determination of behavior and results. Approximately eighty-five per cent of all the plantings formerly made in the unglaciated portion of the region were found in the states of Ohio and Indiana. Of these, as well as of those of the other states, very few were old enough to yield much evidence of ultimate success, a large majority having been made within the past eight years. The distribution of plantations is neither wide enough nor uniform enough to test differences in behavior of species under various site conditions. Also, the extent to which exotics rather than native species have been planted has lessened the chances for evaluation of the latter in planted stands. In Missouri, very few plantings of any species have been established. Planting in northern Arkansas has been logically limited almost exclusively to shortleaf pine. In central and western Tennessee the two native pines, shortleaf and loblolly, and black locust have been most commonly used. On the favorable soils tulip poplar and other hardwoods have been planted to some extent.

When considering the reforestation of sub-marginal lands, usually with pronounced relief, the prime objective is to establish quickly a forest cover to retard erosion, to protect water-sheds, and to amend soil conditions. Another important objective is to establish a forest stand for timber production; on the better sites this objective may be the principal one. Planting for game cover, recreational values, type conversion, stand reënforcement, and

other purposes may receive varying degrees of attention. It was with the first two primary objectives in view that the survey was made.

Species which will fulfill the purposes set forth must possess certain rather specific qualifications, including ability to endure the "shock of transplanting" on sub-marginal lands; to grow satisfactorily and to produce a forest cover quickly; to form a good litter; to produce a canopy through which enough light may filter for the development of a vegetative ground cover and tree reproduction; to reproduce readily on sub-marginal lands; to produce low cost nursery seedlings; and to yield merchantable products. It is understood that the relative importance of these qualifications may vary with planting sites and with the purposes of planting.

Since present plantations of various species are neither numerous enough nor old enough to provide a sound basis for their evaluation in planting, it becomes necessary to depend upon a combination of records of existing plantations and observations of the distribution and behavior of native species. Accordingly the survey included a study of natural stands and old field regeneration, as an indication of what might be expected from plantations. A brief discussion of natural forest associations is pertinent at this point.

Native Forest Associations. The unglaciated region of the Central States has primarily a hardwood forest formation with its component associations. These range from extensive mixed mesophytic forests in the east to extensive oak forests with some hickory and pine in Arkansas and Missouri, interspersed with fingers of prairie vegetation.

The mixed mesophytic forest, comprised principally of beech, maple, yellow poplar, buckeye, black cherry, ash, chestnut, basswood, white and northern red oaks, is chiefly confined to the valleys of sharp relief. In general, these occur in parts of southeastern Ohio; in unglaciated southern Indiana and Illinois; in eastern Kentucky, including the "knobs" surrounding the "bluegrass"; in eastern Tennessee; and in the dissected loessial bluffs east of the Mississippi river in both Kentucky and Tennessee. Very limited areas also exist in Crowley's ridge in eastern Arkansas and in southeastern Missouri. The type develops best in coves and valley bottoms, and on protected slopes where there is a well aerated soil with a fairly constant supply of moisture and high relative humidity. In places somewhat more poorly drained, beech and maple may become the predominant species of the association.

Swamp forests of the region occur on stream bottom lands and poorly drained upland flats. These areas are largely agricultural and will seldom be classed as sub-marginal lands requiring planting.

When either clear or selective cutting is done in the mixed mesophytic forest, without subsequent cultivation or grazing, the same forest association often returns with the species possibly occurring in different relative percentages. However, near the tension zone between the mixed mesophytic forest and the oak-hickory or other types on the dry upper slopes, more often the more xeric species return. When cutover lands have been subjected to fires, grazing, cultivation, or to any combination of factors which destroys the forest ground

cover, litter, and soil structure, there results in most cases a development of a more xerophytic association of oak, oak-hickory, oak-pine, or pure pine.

Oak, oak-hickory, oak-chestnut, oak-pine, or pine types have occupied and still occupy the dry ridge tops and excessively drained upland flats. Following abandonment of cutover lands, the factors of the environment are such that only the most drought resistant oaks, hickories, and pines form the primary forest associations. These associations have been greatly extended in area at the expense of the more mesophytic ones since the early settlement operations of the white man in the region began during the latter part of the eighteenth century. This extension of types has been progressing more rapidly during the last half-century.

Of all the species occurring naturally in the region and used for planting, the southern yellow pines - shortleaf, pitch, and Virginia - appear to reproduce best on abandoned lands. Loblolly pine also occurs naturally in southern Tennessee, where it reproduces well. In southern Ohio the first three species are found in association, or singly in pure stands, or mixed with hardwoods. In Kentucky, all three species occur generally south and east of a line drawn through the western edge of the Cumberland Plateau; but west of the line only Virginia pine has been observed in any abundance. Virginia pine is distributed throughout the "knobs" region and in the western coal field about Dawson Springs. West of the Cumberland Plateau in Tennessee pine is limited to a few isolated areas of shortleaf and Virginia pines, principally in the region of the Tennessee river on outcrops of the Mississippian and Cretaceous formations, and to small areas of loblolly in McNairy County. Southern Indiana contains only Virginia pine in very local occurrence. In southern Illinois, shortleaf pine is confined to small stands in Union County, near Wolfe Lake, and in southern Randolph County. Likewise, only shortleaf pine occurs in southern Missouri and northern Arkansas. However, it occurs intermittently over extensive areas of the same geological formation. In the original forests, due to the prevalence of more tolerant hardwoods, the native southern yellow pines were largely confined to restricted areas on ridges and upper exposed slopes. After the opening up of the neighboring hardwood stands by settlers, pine reproduction occurred wherever seed was available or where trees were transplanted near buildings, explaining in part the isolation of many stands.

Certain soil factors have rather definitely limited most of the native conifers to given areas in the region. It may be observed that the distribution of pines, with the exception of Virginia pine, is almost universally confined to residual sandstone soils and cherty mantle, both materials being well drained and aerated. Eastern red cedar occurs on residual limestone soils, limestone outcrops, and residual soils derived from sandstones impregnated with calcium carbonate. It does not seem advisable at present to recommend planting of the native pines on tight, poorly-drained soils or soils with much available calcium, if good growth and reproduction are desired. Nor does it seem feasible that red cedar may be successfully established on heavy acid soils.

White pine grows in limited areas of the Central States. Isolated stands occur in protected places on sandstone soils in northeastern Iowa as far south as Muscatine, in Illinois as far south as LaSalle, and in Indiana as far south as Turkey Run State Park. In Ohio, still larger isolated stands of trees extend from Lake County, northeast of Cleveland, to Monroe County in the southeastern

part of the state. An extensive area in Kentucky, east of the "blue-grass," centering in Wolfe County and extending into the counties of Lee, Estill, and Menifee, contains native white pine in admixture with many species of mesic hardwoods in valleys and on protected slopes, and less frequently with pitch and shortleaf pines on drier sites. Locally, white pine often makes up a high percentage of the stand and is commercially important. In openings where forest soil and cover conditions have been not too greatly deteriorated, reproduction is common.

Other native northern conifers appearing in the Central States are hemlock, larch, and white cedar. Southern cypress occurs in swamps and river bottom lands as far north as southern Indiana; but, along with the northern conifers just mentioned, may be dismissed from serious consideration in a planting program that must deal largely with eroding, abandoned lands where frequent fluctuations of many site factors - primarily soil moisture, soil and air temperature, and relative humidity - are extreme.

Since most of the sub-marginal land of the central hardwood region lies within the transition zone between northern and southern forests as well as in the zone approaching prairie conditions from east to west, the difficulty of selection of species for planting is accentuated.

Conifers Versus Hardwoods. From observations made on the natural reproduction of primary forest associations on abandoned lands and in plantations in the unglaciated area, it has been well verified that the less exacting of the conifers become established more readily under adverse site conditions than do most hardwoods. On the deteriorated soils, early increment of these conifers greatly exceeds that of the hardwoods, with the possible exception of black locust. Upon these premises it is logical to confine planting on sub-marginal land largely to coniferous species.

As stated above, the forests of the region are primarily a hardwood formation. Markets have been established for hardwood species in the industries which are dependent upon them throughout the region. To attempt to change permanently the general physiognomy of the formation would be folly. To attempt to produce the softwoods to compete in the markets with regions already producing them would also be folly. It should be recognized that reforestation with conifers, therefore, is recommended as a means of hastening restoration of the hardwood forests through soil improvement and cover establishment. However, it may be desirable to introduce yellow pines for permanent management as oak-pine forest on the poorer, drier slopes of the region, which never were and never will be good hardwood sites. Particular reference is made to such areas as are found in the Ozark region of southern Missouri and northern Arkansas, where hardwood forests are composed mainly of the less valuable post, black, and blackjack oaks.

It will sometimes be feasible to do a limited amount of planting of hardwood species on good soils in the bottomlands and coves, and on protected slopes of the unglaciated region. Where such planting can be executed successfully, a number of stages in the succession of associations from the otherwise nurse crop of pines to the hardwood forest may be eliminated. This condition is also being brought about on many old fields by a natural nurse cover of sassafras and persimmon. Since the motive back of most hardwood plantings is production of valuable products such as may be obtained from black walnut, yellow poplar, white

and red oaks, relatively few species are being planted. These are all mesophytic species with tap roots which sustain much injury in the processes of seedling lifting and transplanting. Too often, failures have resulted in plantations on over-drained, exposed areas as a result of the limited root absorbing surface of the seedlings. Field seed spotting of the larger fruited species is being more widely practiced to eliminate the handling of seedlings.

The value of black locust for erosion control, for site improvement as a nurse crop cover, and for the production of fence posts is generally recognized, as is the susceptibility of this species to serious damage by the locust borer, especially on sites where growth is slow. Because of its good qualities and in spite of the danger of severe losses, black locust is being extensively planted for erosion control at the present time. On the lighter, better drained soils site improvement is often surprisingly rapid, and under many relatively young plantings in the region excellent reproduction of other hardwoods has become established. It is decidedly questionable if black locust planting should be continued at the present rate.

Native Conifers Versus Exotic Conifers. Final decision regarding the choice of indigenous or exotic species for forest planting in this region should be made only after due consideration has been given to the relative degrees of success of both in plantation. Although final success of any planting cannot be determined until maturity, growth characteristics and certain responses of planted species to their environment during the early years of establishment are criteria upon which certain evaluations may be based. At least, unpromising species for reforestation can be discarded.

In the northern states of this region such exotics as Norway spruce, Scots, Corsican, Austrian, jack* and Norway pines have been planted extensively. This general reliance upon exotics for reforestation is certainly traceable to the European influence upon early American forestry. The doubtful wisdom of this has been demonstrated repeatedly by failures due to unsatisfactory conditions for growth, and to their susceptibility to attack by insects and fungi. At present, the ratio of exotic stock to native stock produced for field planting is being decidedly lowered.

In establishing a forest cover by planting it is desirable to use species which at a later age will reproduce abundantly under highly fluctuating site factors; otherwise the task of replanting the area probably will recur after some unforeseen disaster or after harvesting the first crop. Observations made in the unglaciated areas of many twenty to thirty-year-old plantings and older isolated trees of exotic species, which are producing viable seed in abundance, revealed that reproduction has been limited to Scots and jack pines. Occasional seedlings of these species are establishing on protected areas only where there are good soil moisture conditions or where the soil approaches that under forest influences. The poor reproduction of planted exotics indicates strongly the futility of depending upon these species, either for the continuance of a forest cover until native species replace them through succession, or for the extension of a forest cover beyond the limits of plantations. The experience of nurserymen has shown that seedlings of northern evergreens in seedbeds are severely damaged in this region by exposure to long periods of direct sunlight accompanied by high temperatures at the soil surface.

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*Native American species, which are not indigenous to this region, are classed with exotics.

To insure a regeneration of our more desirable hardwood forests following planting of conifers, the site conditions must be altered to the extent that hardwood seeds will germinate and seedlings survive beneath the canopy. The exotics most commonly planted - Norway spruce, Scots, and Norway pines - produce dense foliage and canopies upon closing of the crowns. The shade is intensified under these stands, which usually show only slight differentiation of crown classes. This condition is especially true of the Norway pine. Beneath each of these in older plantings the ground is almost devoid of vegetation, either herbaceous or woody. Starvation of seedlings is probably one cause. The thick, slowly decomposing litter, which forms a poor seedbed, may be a further limiting factor. White pine is the only indigenous species used for planting which produces dense shade and heavy litter, equal to those of the exotics. Unlike the exotics, white pine develops excellent differentiation in crown classes. Shortleaf, pitch, and Virginia pines produce a thinner foliage; and in plantation as well as in natural stands, there is often a ground cover composed of herbaceous and shrubby species and reproduction of hardwoods and pines. The desirable two or three-story forest is thus developed.

The production of nursery stock of the exotics involves greater expense than that of the native pines. Generally, the planting stock of the exotics used in this region is three years old, seldom two, and often it is four years old. It is needless to enumerate the well known phases of nursery work which become costly in the time required to develop these transplants. In the northern states of the region, men who have planted shortleaf, pitch, and loblolly pines prefer 1-1 transplants. Farther south, where 1-0 seedlings are almost universally produced, the final cost of production is approximately one-fifth of that for the exotic species.

Recovery after damage by fire, grazing, and insects varies with species. None of the exotics considered here are known to sucker or sprout following severe injury by the agencies mentioned; but it is common knowledge that shortleaf and pitch pines develop new shoots from adventitious buds after damage, and that seedling sprouts often grow into well formed trees.

Although species most suitable for a quickly developing forest cover are of first consequence, especially for erosion control planting, attention should be given to the relative values of the final planted crops. The real commercial value of a species in any region does not depend wholly upon its wood characteristics, but also upon a certain scale of production which will supply the demands of regional wood-using industries. It does not seem advisable to introduce foreign species or native American species from regions far beyond the range of our central hardwoods and the associated pines in an attempt to create new local markets or compete with production of the exotics within their ranges, especially when we have so many valuable native species in the region.

Within the respective ranges of the native conifers - shortleaf, pitch, Virginia, loblolly, and white pines and eastern red cedar - the choice of species for planting should be based first upon consideration of their responses to site conditions, and second upon their commercial importance.

Until we can secure substantial data from mature stands of carefully planned experimental plantings, we are justified in making large scale plantings only on the basis of ecological principles applied to the native species of the region.